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Modified Scintillation Detectors and Protocols to Improve Slim-Hole Gamma Ray Detector Stability and Log Stability in Low Radioactivity Environments

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Slim-hole Gamma ray tools using small (1" x 2", 0.5" x 4" or 1" x 4") sodium iodide (NaI) scintillation crystal detectors are best suited for high radioactivity environments such as those encountered in radioactive minerals exploration. Recent sediments at the Lawrence Livermore National Laboratory (LLNL) Livermore Site, Livermore, California have very low natural gamma radiation levels, with minimal sand/clay gamma ray contrasts. In this setting the small NaI scintillation detectors generate inadequate counting statistics to provide reliable sand/clay discrimination or stratigraphic correlation. This inadequacy is characterized by highly unstable detector count rates and poor agreement in log repeat sections.

At the LLNL Livermore site, slim-hole natural gamma ray log detector count rate stability and log repeat section agreement have been significantly improved by using gamma ray logging tools with larger (e.g., 1" x 8" and 1.25" x 6") crystal NaI scintillation detectors. The improvements obtained with the larger crystal volumes greatly exceeded those obtained by using slower logging speeds and/or lengthening the counting time. We have also developed statistical measures of gamma ray detector stability and repeat section agreement which provide greater insight into gamma ray logging tool performance at a given site than the Poisson distribution assumption, currently in common use. These approaches should be of value to other sites with low natural radioactivity environments.

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